Centerville Hydroelectric System, Powerhouse
Butte Creek
Centerville
Butte County
California

HAER No. CA-127-A

HAER
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Western Regional Office
National Park Service
U.S. Department of the Interior
San Francisco, California 94107

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HISTORIC AMERICAN ENGINEERING RECORD
CENTERVILLE HYDROELECTRIC SYSTEM, POWERHOUSE (HAER NO. CA-127-A)

Location: Butte Creek, 0.3 miles west of the intersection of Centerville Powerhouse Access Road and Humbug Road in the vicinity of the community of Centerville, Butte County, California

USGS Paradise West Quadrangle (7.5' series), Universal Transverse Mercator Coordinates: 10, 615075 Easting, 4405000 Northing

Date(s) of Construction: 1907, 1914 (modified)

Engineer/Architect/ Builder/Fabricator: Frank G. Baum (Chief Engineer);
Arnold Pfau (Turbine Designer)
Josiah P. Jollyman (Electrical Construction Supervisor)
James H. Wise (Hydraulic/Civil Engineer Design)

Present Owner: Pacific Gas and Electric Company
77 Beale Street
San Francisco, CA 94106

Present Use: Hydroelectric Power Generation

Significance: The Centerville installation of the Francis turbine generation unit in 1907 was only the fifth Francis turbine installed on the Pacific Coast, and the first relatively high head turbine installed in the west, representing an innovative approach to long distance, high-voltage transmission. The success of the Centerville project encouraged further high head turbine installations throughout California and contributed significantly to the development and expansion of hydroelectric power generation throughout the nation.

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During the 1890s California's engineers and entrepreneurs began to experiment with the use of water to generate power. Through the conversion of existing sophisticated water delivery systems and hydraulic power technology developed in the Sierra Nevada by miners, California engineers became pioneers in hydroelectric power development and were continuously on the leading experimental edge of the field through the 1920s (Williams 1984:1). By 1900 there were 18 small powerhouses in the Sierra Nevada foothills supplying power to nearby communities. Location of these early plants was determined by an abundant water supply, an in-place ditch system to transport water, and the need for low cost power in a local community (Doble 1905:75-98; Galloway 1912:315)

Centerville Hydroelectric System

The development of the Centerville Hydroelectric System was a direct result of the exorbitant prices for gas and electricity charged by the Chico Gas Company in the nearby town of Chico. In 1898 local entrepreneurs, seeking altematives to the services provided by the Chico Gas Company, formed the Butte County Electric Power and Lighting Company with the express purpose of building a hydroelectric plant to supply cheaper electricity to the town. Community businessmen acquired title to the abandoned Bostwick Gold Mining Company ditch and flume (built in 1887), and chose a site on Butte Creek (Anonymous 1903:172; Fowler 1923:214-215).

After months of waiting for equipment and supplies, work on the new powerplant began. The powerhouse, a utilitarian reinforced concrete structure, measured 110 feet long by 32 feet wide and contained two 58-inch Pelton water wheels operating at 400 rpm. Water was directed to them down the reconstructed canal and flume system, into the header box, through penstock and deflecting nozzles controlled by Pelton governors. Two exciters were driven by two 18-inch Pelton wheels, direct connected and running at 1,300 rpm. The generators delivered 60 cycle current at 2,400 volts to a bank of three 150 kilowatt transformers, raising the voltage to 16,500 for transmission (Henry 1901:32; Williams 1984:6). Two transmission lines were strung from the powerhouse: one 15 miles to Chico and a second 32 miles south to the gold dredges operating near Oroville. On May 23, 1900, the first Centerville hydroelectricity lit incandescent lamps in downtown Chico.

Between 1900 and 1907 several minor changes occurred to the system. In 1904 ownership of the powerplant was acquired by the California Gas and Electrie Corporation (CGEC). The CGEC installed a second 24-inch penstock at Centerville, as well as a Doble needle regulated nozzle and a Doble 48-1/2-inch water wheel. The nozzle and wheel drove a 900 kw Stanley inductor, three-phase, 60 cycle generator. Three water-cooled Stanley 600 kw transformers were also installed. The major change to the Centerville system occurred in 1907, however, with the installation of a high head turbine at Centerville (Williams 1984:8-9).

Francis Turbine at Centerville

The attention of the engineering world turned to Centerville in 1907. In a radical departure from ordinary practices, CGEC installed a 5,500 kw generator driven by a 9,700 hp Allis-Chalmers Francis-type turbine at Centerville. The turbine operated under a static head of 577 feet from headwater surface to center of runner and total head of 591 feet to normal tail water. Publications at the time noted that the installation "deserves a remarkable place in the history of hydraulic turbine engineering, as never before has a Francis wheel been designed for the extremely high head of 550 feet" (Journal of Electricity, Power, and Gas 1907:504).

At the time of the Centerville installation, only four other Francis-type wheels had been installed on the Pacific Coast and the highest head, at Bishop Creek in central California, only had a head of 408 feet. All had been installed between 1903 and 1907 and engineers were still debating at the time about the merits of the turbine compared to the tangential Pelton-type water wheel. Problems with water regulation, operation under varying loads, wear from silt and gravel, and maintenance difficulty plagued the turbine when used under high head (Homberger 1908:143-144).

Installation of the turbine at Centerville was the brainchild of Frank G. Baum. Baum received a graduate degree in electrical engineering from Stanford University in 1899 and immediately began working on the Electra powerhouse project on the Mokelumne River for Standard Electric Company. After the Electra project he returned to Stanford and taught at that institution from 1900 to 1903. While he was teaching he was paid as a consultant to the Bay Counties Power Company. In 1903 Baum joined CGEC as engineer in charge of operations and construction and focused on solving problems connected with synchronous operation of scattered power plants and high-voltage long distance transmission. He stayed with CGEC until 1907, initiating the Centerville project. After a five year stint as a private consultant, Baum returned to the company (by then a subsidiary of Pacific Gas and Electric Company [PG&E]), working on major projects such as the Spaulding Dam, South Yuba-Bear River project, several powerhouses, and the enormous Pit River project in Shasta County (Coleman 1952:151-152).

According to Coleman (1952:151), Baum's outstanding contributions to the electrical industry included development of the correct theory of the performance of long, high-voltage lines, improvement of the pioneer 60,000-volt transmission system and switching equipment, and design of the pioneer 220,000-volt transmission line from the Pit River to the San Francisco region. Baum was a firm believer in interconnected electrical power networks and he argued persuasively in the 1920s for development of a nationwide system (Baum 1915; 1923a, 1923b).

While Baum brought his vision of long distance, high-voltage lines to the Centerville project, other engineers contributed significantly to the installation of the Francis turbine. Arnold Pfau, a design engineer with Allis-Chalmers Company, makers of the turbine used at

Centerville, designed the overall project around the turbine. Josiah P. Jollyman, supervisor of electrical construction, oversaw the actual replacement of the original two 58-inch Pelton wheels with the new turbine. James H. Wise directed the hydraulic and civil engineering work (Williams 1984:11).

Jollyman and Wise, the other two CGEC engineers on the project, both played important roles in the development of hydroelectricity in California. Jollyman began his career at the DeSabla Powerhouse, seven miles upstream from Centerville, in 1903, soon after his graduation from Stanford University's electrical engineering program. He distinguished himself during the 1907 Centerville project, when he designed a load limiting device for the turbine, using a Lombard Type "N" Govemor. This proved to be a significant innovation and was later used on the Halsey and Wise powerhouses turbine installations. Except for a brief stint with another company between 1909 and 1911, Jollyman remained with PG&E until his retirement in 1945 (Coleman 1952:151).

Wise graduated from the University of California Berkeley and joined CGEC as a surveying crew instrument man. By 1907 he had worked his way up to civil and hydraulic engineer and by 1911 was assistant general manager at PG&E. Wise initiated the South Yuba-Bear River hydroelectric project and started construction of Spaulding Dam and Drum Powerhouse. Wise died in 1912 at the age of 32 but his importance to the hydroelectric development in Califomia was immortalized through the creation of the Wise Powerhouse and Wise Memorial Library at PG&E (Coleman 1952:151).

The success of the Centerville turbine installation was due to the collaboration of Jollyman, Wise, and Baum, and the turbine design of Pfau. The installation required major reconstruction of several aspects of the original Centerville plant. The Centerville Canal, an 8.3-mile water conveyance system, was overhauled with deep sand boxes and waste gates installed at intervals along the canal to help capture and remove silt. In addition, a large settling basin was built 300 feet above the header box, a grizzly was placed in the canal just above the basin to allow heavy sand and gravel to pass into the settling basin, and construction of a 25-by 18-foot, 20-foot deep reinforced concrete penstock intake was needed (Williams 1984:12; Wise 1908a).

In addition to the two existing penstocks, a third riveted steel pipe was added to the system. This pipe was 42 inches in diameter for the first 1,819 feet and 36 inches in diameter for the last 675 feet. It was supported by concrete piers at intervals with six inch air valves placed at critical points. At the powerhouse all three pipes were joined together by a multiple casting with the "T" placed in one of the 24-inch pipes for the 900 kw water wheel (Wise 1909:41-46).

Installation of the turbine in 1907 also required modification of the original powerhouse. First, the concrete walls were raised to permit the addition of a 60,000-pound capacity Cyclops Iron Company hand-operated crane. The crane ran along a runway that was 19.25 feet above

the floor and extended along the length of the building. In order to support the crane steel roof trusses replaced the original wooden ones and a 25-foot by 32-foot addition was added to the north end of the building to house the new machine shop.

The interior of the old powerhouse also underwent modification to facilitate the new turbine. The two old 400 kw Pelton units were removed and the floor space was used for the new turbine. A Lombard Type "N" governor, Jollyman's load limiting device,was installed, along with a 45-inch gate valve. A bolt flange coupling connected the turbine to a 5,500 kw three-phase, 60 cycle, 2,400 volt, 400 rpm Stanley generator. Six 840 kw and three 360 kw water-cooled transformers were installed, receiving cooling water from a 10-foot diameter, six-foot deep reinforced concrete tank (Jollyman 1909:156-157; Williams 1984:12; Wise 1908b:320-323, 1908c:125-129) (see photographs CA-127-1, CA-127-A-12 to -19 and drawings CA-127-A-20 to -22).

Additional modifications to the powerhouse included construction of a turbine draft tube and tunnel into a weir pool, allowing the measurement of the quantity of discharged water. The tailrace spill from the 900 kw unit was also directed into the weir pool, enabling measurement of all the water passing through the plant. A Stanley 60 kw exciter was also installed, driven by a small impulse wheel (Fowler 1923:216-217; Williams 1984:13).

Along with the powerhouse alterations came a new reinforced concrete switchhouse, located directly above and behind the powerhouse (see photograph CA-127-B-1). The 60,000-volt transmission lines ran from the transformers to the switchhouse. Inside, "Baum" high-tension switches and open-air switches, hand-operated from the powerhouse switchboard, served to cut on or off power on lines from the De Sabla plant upstream (Fowler 1923).

The success of the Centerville turbine was partly responsible for the decision of PG&E engineers to install a turbine with a 328-foot head at their new Halsey plant and one with a 519-foot head at the Wise station. Although the Centerville and other PG&E turbine installations were no longer considered truly "high head" by the mid-1920s, they were clearly pioneering efforts in adapting the turbine to high head electric use (Hutchinson 1925; Jollyman 1917; Williams 1984:17-18).

Changes to Centerville Powerhouse

The Centerville Francis turbine generation unit proved its worth over the next several years. In 1914, after seven years in operation, wear on the turbine runner was heavy enough to justify renewing the runner, guide vanes, and plates beside the vanes. The new parts also had balancing chambers on both sides of the runner, a design perfected since the 1907 installation of the turbine. This work was the only major modification of the generation unit.

Since 1914 the Centerville plant has undergone routine maintenance and upkeep changes. Updated transformers, switching gear, and a Limitorque piston type hydraulic governor for the turbine have been installed. The small Pelton wheel operating the 60 kw exciter was removed, as was the governor pump. The runner on the turbine and the buckets on the 900 kw wheel have undergone repair several times, and the generators have been rewound. By 1928 the two original 24-inch penstocks (installed in 1900), were removed and replaced with 30-inch penstock (Hunt 1928:740; Johnson 1950:196. In 1959 the plant was converted to semi-automatic operation. These changes have not affected the general layout and operation of the powerhouse but have been more maintenance oriented. Today, the Francis turbine generation unit remains in operation at the plant in the original configuration designed by Baum, Wise, Jollyman, and Pfau (see photographs CA-127-A-1 to A-11 for illustrations of the 1992 appearance of the unit).

On January 31, 1992 PG&E received an order from the Federal Energy Regulatory Commission (FERC) amending their license for the DeSabla-Centerville Hydroelectric Project (FERC 803-014). PG&E, under the terms of this license order, proposes to modify the Centerville Development by replacing the existing Centerville powerhouse with a new underground powerhouse and replacing the existing generating unit with a new generating unit. This undertaking will have an effect on the 1907 Centerville Francis Turbine, a property eligible for inclusion in the National Register of Historic Places. Article 408 of FERC's order amending the license and a Memorandum of Agreement between FERC, the California State Historic Preservation Officer, and the Advisory Council on Historic Preservation requires PG&E to mitigate the effects of this project through HAER documentation CA-127-A.

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